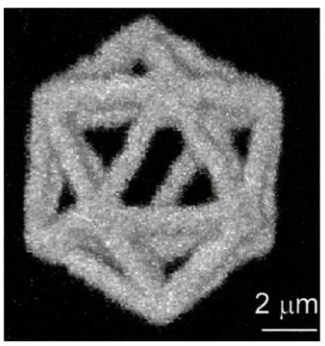
EDITORS' CHOICE

edited by Stella Hurtley

PHYSICS

Flash Work on 3D Ministructures

Light-induced polymerization of photosensitive polymers has already led to the possibility of fabricating intricate micrometer-sized three-dimensional (3D) structures. The real potential will now lie in forming optically active structures. Although postfabrication infiltration of a polymerized resin with fluorescent chromophores can render the structure optically active, doping efficiency tends to be rather low and the resulting optical properties poor.



Fluorescent 3D icosahedron.

Sun *et al.* describe a polymer resin uniformly doped with molecules of the fluorescent dye rhodamine, which can form fluorescent 3D structures. The flexibility offered by being able to tune polymer and dye properties should prove useful for integrating designed optical activity and a controlled fabrication process to produce miniature structures with specific functionality. — ISO

Appl. Phys. Lett. **79**, 1411 (2001).

GEOPHYSICS

Core-Mantle Boundary Cells

The core-mantle boundary (CMB) marks a major chemical and physical contrast between an outer core of liquid iron alloy and a lower mantle of solid silicate minerals. The two phases may mix on a grain-size scale so that the liquid infiltrates the solid and some minerals dissolve. This allows the liquid to become saturated with lighter elements, and this saturated liquid can form a distinct layer at the CMB.

Narteau *et al.* developed a cellular automata method to simulate this mixing to determine the fine-scale structure at the boundary. They used three types of centimeter-sized square cells: iron liquid, iron liquid saturated with silicon and oxygen, and solid silicate. Adjacent cells were allowed to interact and change their state based on plausible rates of dissolution, crystallization, and diffusion. The simulations predict a 65-cm-thick layer of saturated liquid at the CMB after about 5 years, and over longer time scales, thicker layers with undulations form. The formation of a stable saturated layer with undulations may change mantle convection and fluid core motions, leading to larger scale effects on core-mantle coupling and on the whole Earth. — LR

Earth Planet. Sci. Lett. **191**, 49 (2001).

ECOLOGY/EVOLUTION

In the Shade

Plant species display a wide range of tolerances to levels of light and shade—some being extremely shade-tolerant, others being light-demanding. Also, the complement of photosynthetic and associated pigments in the chloroplasts of plants varies according to the intensity of light to which the plants are exposed. To assess whether patterns of pigment composition are adaptive or simply indicative of acclimation to growing conditions, Rosevear *et al.* germinated seeds from 23 plant species from a variety of British habitats and grew the plants under different light conditions before analyzing pigment content. The growth conditions were more important in determining pigment content than was the original source habitat, which suggests that the selective forces during shade adaptation do not fundamentally alter the light-harvesting machinery. — AMS

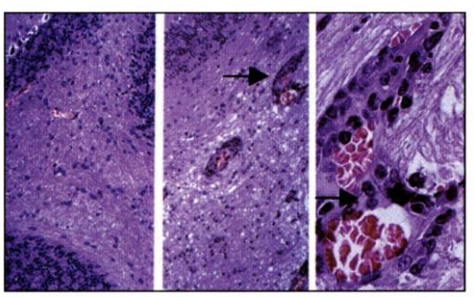
Funct. Ecol. **15**, 474 (2001).

IMMUNOLOGY

Letting Killers Through

Multiple sclerosis (MS) is an immune-mediated demyelinating disease affecting nerves of the central nervous system (CNS). Animal models of MS have illuminated how helper-type $CD4^+$ T cells could influence the human form of the disease. Because $CD8^+$ killer T cells are involved in cell-mediated autoimmunity and can be detected in the lesions of some MS patients, it is possible that they too might contribute to the pathology observed in MS.

To test this, Huseby *et al.* generated $CD8^+$ cytotoxic T cell clones from mice immunized with a protein component of nerve myelin sheath. Transferring these cells into normal mice caused loss of coordination, spastic reflexes, and paralysis. The CNS lesions responsible for these effects were generally restricted to small blood vessels of the brain and proximal regions of white matter, a pathology that is distinct from other forms of CD4-mediated demyelinating disease. This type of perivascular lesion in the upper CNS suggests that $CD8^+$ T cells might induce distinct forms of MS or mediate particular stages of the disease. — SJS



Diseased (middle and right) brain tissue shows inflammation and infiltration by blood vessels as compared with controls (left).

J. Exp. Med. **194**, 669 (2001).

MOLECULAR BIOLOGY

Sigma Holds On

Many decades of work have provided details of the molecular mechanism and machinery needed for prokaryotic gene expression. Bacterial genes are transcribed by the RNA polymerase enzyme, which associates with a sigma subunit during transcription initiation. Afterwards, the sigma subunit is released from the polymerase and an elongation factor, NusA, binds. NusA remains bound to the polymerase throughout transcription elongation and termination and is then removed to allow sigma to bind once again for transcription reinitiation. This is termed the "sigma cycle."

In two recent papers, Bar-Nahum and Nudler used a purification strategy and Mukhopadhyay *et al.* used a fluorescence resonance energy transfer (FRET) technique to show that some populations of *E. coli* RNA polymerase retain s70 throughout elongation. These studies question the traditional view of bacterial transcription and the sigma cycle,

CONTINUED ON PAGE 1957

SOURCE: (LEFT) SUN *ET AL., APPL. PHYS. LETT.* **79**, 1411 (2001); (RIGHT) HUSEBY *ET AL., J. EXP. MED.* **194**, 669 (2001)

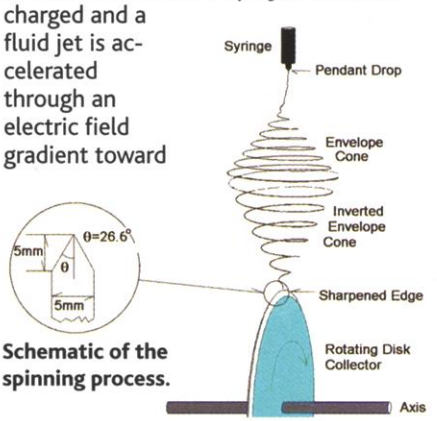
as well as the suggestion that initiation and elongation are mechanistically distinct. Sigma retention may represent a regulatory mechanism used by the cell to allow multiple rounds of transcription at particular promoters. — BAP

Cell **106**, 443; 453 (2001).

POLYMER SCIENCE

Tangle Free

Polymer fibers with submicrometer diameters can be produced by electrospinning, in which a reservoir of polymer fluid is charged and a fluid jet is accelerated through an electric field gradient toward a grounded collector. Unfortunately, the same instabilities that cause the fibers to become very narrow also make it difficult to control their orientation; instead, they form a tangled mat.



Schematic of the spinning process.

Theron *et al*. replaced the standard static or rotating drum collector with a rotating disc with a sharpened edge that focused the electric field at the collector. Unlike conventional electrospinning, in which the lateral motion of the fiber increases as it approaches the collector, the lateral motion of the fiber narrowed as it approached the disc. Most of the fibers collected near the edge of the disc, and residual charges on the fibers repelled each other to create isolated strands. The edge of the disc can be covered with a surface, such as carbon tape, to aid in the further processing of the polymer fibers. At longer collection times, a braid of well-oriented fibers formed, with the potential for use as a reinforcing material. — MSL

Nanotechnology **12**, 384 (2001).

CLIMATOLOGY

Understanding Recycling

The solar energy absorbed by Earth is continually redistributed from warmer low latitudes to cooler high latitudes by oceanic and atmospheric circulation. Climate models and models of ocean and atmospheric circulation need to use accurate values of how much heat is transported by each of these pathways.

Trenberth and Caron have reanalyzed data from the National Centers for Environmental Prediction–National Center for Atmospheric Research (NCEP-NCAR) and the European Centre for Medium-Range Weather Forecasts (ECMWF) for 1985 to 1989 and computed the annual mean heat transport by the atmosphere and ocean in order to construct a global picture of meridional heat transport. They compared their results to direct oceanographic measurements and estimates from successful, stable, coupled climate models and found that the values derived from various approaches seemed to be converging. However, a larger fraction of energy appears to be transported toward the poles by the atmosphere than has been indicated by previous studies. — HJS

J. Climate **14**, 3433 (2001).

HIGHLIGHTED IN *SCIENCE*'S SIGNAL TRANSDUCTION KNOWLEDGE ENVIRONMENT

Science's stke www.stke.org

Out, In, and Out Again

Monocytes participate in inflammatory responses, wound repair, and other processes and interact with activated platelets and endothelial cells through P-selectin glycoprotein-1 (PSGL-1).

Mahoney *et al*. show that binding of PSGL-1 to P-selectin increases the activity of the kinase mTOR (mammalian target of rapamycin) involved in cell proliferation. Urokinase plasminogen activator receptor (UPAR) translation is enhanced to influence adhesion and migration. UPAR is also transcriptionally regulated and has multiple actions, such as interaction with extracellular matrix vitronectin. Indeed, the increased synthesis of UPAR in response to the PSGL-1 causes enhanced adhesion of monocytes to vitronectin. Thus an "outside-in" signal from interaction of a cell with P-selectin triggers an intracellular signaling pathway that ultimately signals back to the outside through increased expression of UPAR, enhancing binding to vitronectin. These changes could mediate some of the therapeutic effects of rapamycin. — LBR

Proc. Natl. Acad. Sci. U.S.A. **98**, 10284 (2001).

CREDITS: THERON *ET AL.*, *NANOTECHNOLOGY* **12**, 384 (2001)